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REPORT

OF THE

JOINT COMMISSION,

CONSISTING OF THE

Board of Harbor Commissioners

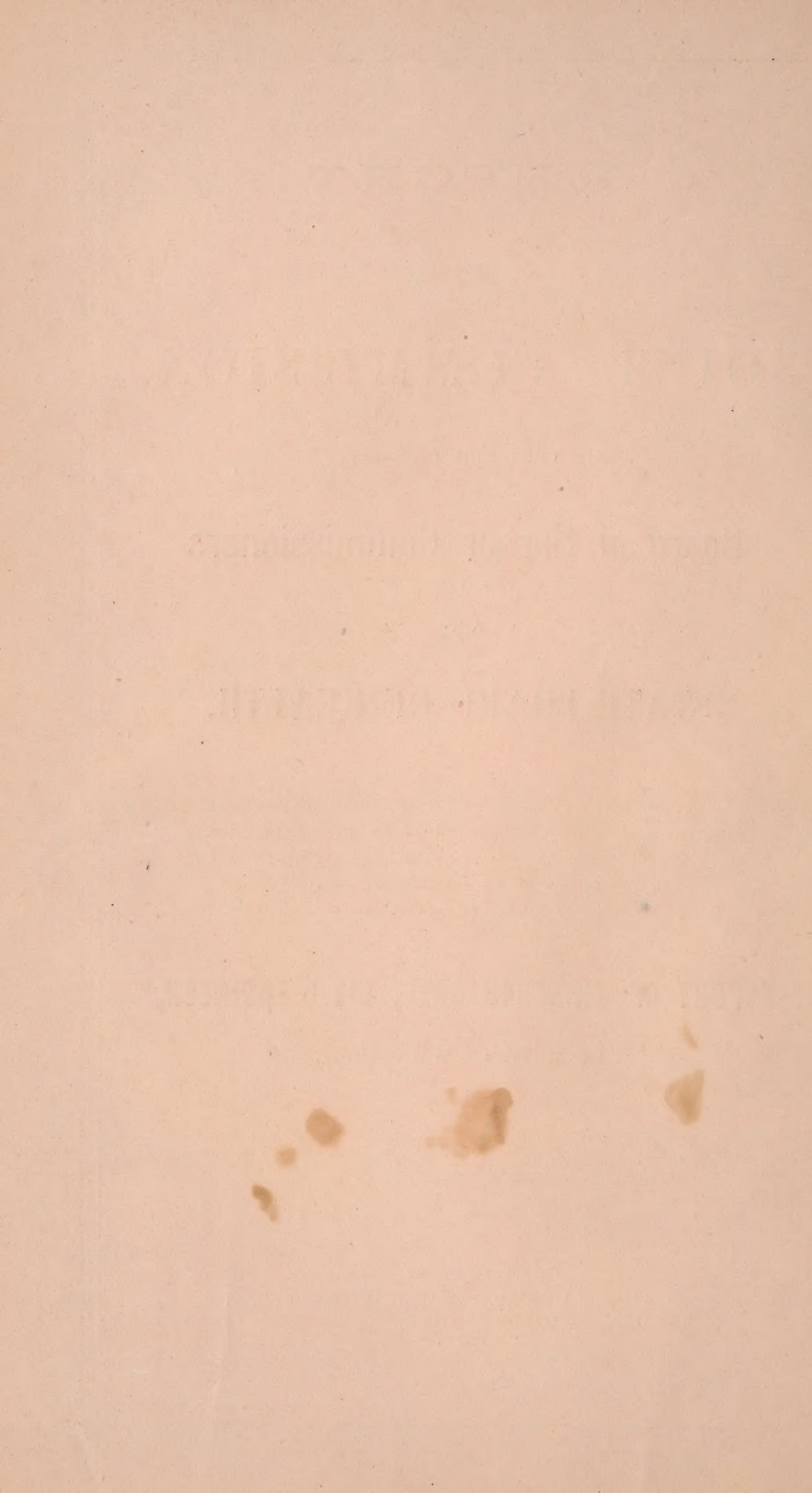
AND

STATE BOARD OF HEALTH,

CHARGED BY THE LEGISLATURE WITH THE DUTY OF DEVISING A PLAN
FOR THE ABATEMENT OF THE MILLER'S RIVER NUISANCE,
SO CALLED, AND REPORTING THE SAME TO
THE CITIES OF CAMBRIDGE AND
SOMERVILLE, WITH THE

**REPORT OF PHINEAS BALL, CIVIL ENGINEER,
TO THE COMMISSION.**

BOSTON:
J. A. CUMMINGS & CO., PRINTERS,
102 Washington Street,
1872.



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*To the Mayors and Aldermen of the
cities of Cambridge and Somerville :*

The Joint Commission, consisting of the Board of Harbor Commissioners of the Commonwealth, and the State Board of Health, created by Chap. 353 of the Acts of the year 1872, entitled, "An Act for the abatement of a nuisance in the Lower Basin of Miller's River, and for the preservation of health in the Cities of Cambridge and Somerville," and charged by said Act with the duty of devising a plan of draining and abating a nuisance in a district in said Act described, bordering upon Miller's River in Cambridge and Somerville, and of reporting the same to the Mayors and Aldermen of said cities, hereby transmit the following as their report and the plan devised by them, in accordance with said Act.

After hearing the evidence and arguments of all parties interested in this subject, who appeared before the Commission in answer to its published invitation, the Commission proceeded to choose an Engineer to make such additional independent investigations as would enable it to come to a conclusion which it could feel satisfied met all the requirements of the problem to be solved. Having ascertained the high reputation and large experience in work of this character of Mr. Phineas Ball, of Worcester, the Commission engaged him to make these indispensable investigations. The results of his labors and his reasoning upon these results, are embodied in the elaborate, thorough and exhaustive report to this commission; a copy of which, and of the accompanying plan is appended to this communication.

The Commission has arrived at its conclusions, by considering; First—The causes of the nuisance. Second—The remedies to be applied.

They are satisfied that the nuisance is caused ; First—By the use that is made of the Miller's River basins as receptacles of the sewage draining into Miller's River from large areas of the City of Cambridge, and still larger areas of the City of Somerville ; Second—By the fact that the basins of Miller's River, within the district of the nuisance, in consequence of the absence of any current through them during the ebb tide, the shallowness of some of them, and of the contracted outlets of all of them, act as precipitating basins for the permanent deposit of the whole burden of insoluble animal filth borne up to them by the incoming tide, and collected throughout the whole extent of Miller's River, from Prison Point Bridge, to the farthest limit of the upper basin ; Third—From the fact that the slaughtering establishments below Prospect street, have used the basins of Miller's River to cast into their waters not only blood in large amounts, but also the animal filth from without and within the bodies of over half a million hogs a year, slaughtered in these establishments, and dressed by a process in which each slaughtered hog, while still bleeding, is plunged into scalding water, and there kept until the epidermis, and all the attached dirt are so softened that they can be scraped off. And the Commission further find this cause to be the main cause of the foul and putrid mass of animal corruption concentrated in these basins, and constituting the nuisance to be abated.

The remedies considered by the Commission are ; First—Those that bear upon the prevention of further accumulations of offensive material in this district ; Second—The disinfection or removal of existing offensive accumulations.

To prevent further accumulations, the material that is now deposited here must be deposited elsewhere, and in a locality where it will be taken up by a strong current in the ebb tide, and be scattered and borne out to sea. Otherwise in arresting the action of causes that make a nuisance in this district, another nuisance will be created in another place.

The Commission is of the opinion that Miller's River is an unsuitable place into which to empty a main sewer that

shall have connection with the slaughtering establishments on Miller's River, and receive the animal matter that has heretofore been cast into its waters. Only a connection with deep water, having a strong ebb current, would enable a sewer to empty without offense what it received from these establishments. Charles River and Mystic River only have the accessible deep water, possessing a strong ebb current, and into one or the other or both of these rivers the Commission has no doubt that the sewage of this district should drain.

Cambridge can easily disconnect all its sewers with Miller's River, and direct all its sewage into the Charles. This being done, the plan of providing the two cities with the means of draining their respective territories, so as to relieve this district of offense, is rendered much less difficult. The drainage of Somerville alone then remains to be provided for.

This, in the judgment of the Commission, should be accomplished by directing the outlet of the whole system of sewers in Somerville, toward the Mystic, instead of either Miller's River or the Charles.

In this direction through Washington street to Tuft's Dock, a line to deep water has been found by Mr. Ball, which seems to the Commission to present the most favorable conditions for the construction and maintenance, at the least public inconvenience and expense, of a main sewer, which will drain not only substantially all the territory in Somerville, but also a considerable portion of the territory of Charlestown, on its westerly borders, that now requires, or can hereafter require a proper system of sewerage, emptying into deep water. This is the sixth of the main lines of drainage discussed by Mr. Ball in his report, and is highly commended by the Commission, as original, simple, comprehensive and economical.

Having provided by this system of sewerage against any increase of the nuisance in the district under consideration, the next question is how to provide a remedy for the nuisance that now exists, either by disinfecting or removing

the offensive accumulations that have already gathered. The most obvious, the simplest and most economical remedy, and an effective one, is undoubtedly to fill up with clean gravel the basins that contain these accumulations, and this plan of disinfection is recommended by the Commission.

That the foul mud at the bottom of these basins may do no harm to those who may build over it in the future, the Commission advise that the filling proceed from the sides to the middle of the basin, that a space fifty feet in width be reserved through their whole extent, and that the mud in this space be finally excavated before the gravel filling is completed.

The work of excavation should be done only in the months from November to April inclusive, to guard against the influence which the emanations from this material might have upon the public health.

This reserved canal will serve also to continue the present method of drainage until the new system is in operation. If the Commission were to regard simply the most feasible plan for abating the nuisance arising from existing offensive accumulations, it would make no distinction in the treatment of these basins. The filling of the lower basin with clean gravel, seems to it as truly the best mode of abating the nuisance there as in the basins above. The only other remedy would be to excavate and remove from the basin its foul mud, construct perpendicular walls all around its borders, and extend this wall outside the slaughtering and rendering establishments on its banks, so that it should no longer be the easiest and cheapest mode of disposing of the animal refuse from the great number of hogs here annually killed and dressed, to let it drop through the openings in the floors into the water below; and then establish and maintain an efficient police to enforce the necessary regulations to secure the basin from pollution. The cost of this remedy is estimated by Mr. Ball at \$133,000.00. The cost however of abating the nuisance in this basin by filling, would probably be defrayed by the proceeds of the sale of the land created in the process of abat-

ing the nuisance. But the Statute creating this Commission contains this limitation upon its action: "Which plan shall provide, if practicable, for the preservation and improvement, of so much of the channel and basins of Miller's River, as is now flowed by the tide below the point where the Grand Junction Railroad, in Somerville, crosses such river and basin."

What, then, is the meaning of the word "practicable," according to the intent of the Legislature, as expressed by the Statute? Without reference to the Statute, and according to the ordinary acceptation of the word, it could be practicable, after providing the system of sewerage already described, to abate the nuisance within the limits of the lower basin, by dredging it out, providing perpendicular walls to its sides, and building these walls outside the limits of the establishments on its borders. But the plan for abating this nuisance, while preserving and improving the lower basin, must be practicable, under the Statute, and the means provided by it, for executing any plan this Commission may devise.

The only parties authorized by this Statute, to execute this plan, are the cities of Cambridge and Somerville. If they do not execute the plan, it is inoperative, the Statute is without effect, and the nuisance will remain. The Legislature clearly intended to give these cities a fair opportunity to relieve themselves of this nuisance. The plan must therefore be not merely capable of execution as a matter of engineering, but one which it would be reasonable for both cities of Cambridge and Somerville to execute. For certainly the Legislature could not have intended that this basin should be preserved and improved by these cities, under a plan which it would be unreasonable and unjust to require them to carry into effect, to obtain the relief they desire. In this view certain findings of fact by the Commission that have been already stated, become very material. These are; First—That the cost of abating the nuisance in the lower basin, if it is preserved, will be very much larger than by the plan of filling it up. Second—That establishments on and over this

basin are mainly responsible for the existence of the nuisance within its limits. Third—That there is no known reason that can be given for incurring the great expense necessary to improve and preserve this basin, except the benefit which it is claimed an open water space is to these establishments. The waters of this basin are of no value for navigation, or even as a tidal reservoir to Boston Harbor. They have no æsthetic value, and no sanitary value worth considering. The question then arises whether the plan is a reasonable one for the cities of Cambridge and Somerville to execute, which compels these cities to abate the nuisance in this basin, at a much greater expense than is necessary, merely for the exclusive benefit of the establishments on and over it, which are mainly responsible for the existence of the nuisance to be abated. The Commission believe that such a plan would be grossly unjust to these municipalities, and an unreasonable one for them to execute; that by reason of its injustice, it would be inoperative, and frustrate rather than promote the beneficent intent of the Legislature.

Furthermore, the Commission is of the opinion that the only substantial value the waters of this basin are, or can be to the establishments on and over them, arises from the fact that they can be put to that illegitimate use which is the main cause of the nuisance. Now a plan for abating this nuisance which should spare the lower basin, because of its value for a use which has been the main cause of the nuisance, and must perpetuate that nuisance, would be nugatory and absurd. The Commission therefore decides that the plan for abating the nuisance in the Miller's River district, while providing for the preservation and improvement of the lower basin, is not practicable within the meaning of the Statute.

THE COMMISSION ACCORDINGLY REPORTS THE FOLLOWING
PLAN :

First—That the city of Cambridge complete its system of sewerage, so that such portion of its territory as is now

drained into Miller's River be drained into sewers already made or projected, having their outlets into Charles River.

Second—That the City of Somerville construct a main sewer, from Milk street through Prospect, Washington and Cambridge streets, into Tufts' Dock in Charlestown, on Mystic River, and connect with this main sewer, lateral sewers, in such a manner that whatever now drains into the Miller's River basins, will drain by this main sewer into the Mystic River, and that the City of Somerville obtain the requisite legislation to carry this main sewer through the territory of the City of Charlestown.

Third—That the Cities of Cambridge and Somerville fill up with clean gravel, to the grade authorized by law, all the channel, flats, and basins of Miller's River, lying east of Prospect street in Somerville, and southwest of the Boston and Lowell Railroad; reserving at first from such filling, through the middle of said channel and basins to the outlet under the Boston and Lowell Railroad, a space not less than fifty feet in width, where such a width is possible, until the drainage of the territory of Cambridge and Somerville, now leading into these basins, has been diverted from them into Charles and Mystic Rivers, as hereinbefore provided, and then in the months from November to April inclusive, finally removing from this reserved space the mud which has there accumulated in the process of filling the adjoining areas.

Fourth—It will then remain to enforce those sanitary principles which the Commonwealth has already adopted with reference to industries of the class peculiar to this neighborhood.

The Commission has adopted no temporary measures in regard to this nuisance, because it was conceded by the representatives of both cities, and of all other parties appearing before the Commission, that none could be devised that would give any substantial relief, and such was the unanimous opinion of the Commission.

ESTIMATES.

An estimate of the cost of a main sewer on the line to Mystic River, made by Mr. Ball in his report, as well as the other estimates reported by him, are adopted by the Commission, and it is unnecessary to repeat them. These are all the estimates which, in the opinion of the Commission, the case required.

EXPENSES.

The expenses of the Commission in making the necessary surveys and estimates in the performance of its duty, under the Statute, have been twenty-nine hundred and fifteen dollars and forty-four cents, as shown by the accompanying voucher, and of this sum the Commission determines that seven hundred and twenty-eight dollars and eighty-six cents be paid by the City of Cambridge, and that twenty-one hundred and eighty-six dollars and fifty-eight cents be paid by the City of Somerville, to Josiah Quincy, the Chairman of the Commission.

Boston, December 7, 1872.

JOSIAH QUINCY,
HENRY I. BOWDITCH,
J. N. MARSHALL,
GEORGE DERBY,
W. T. GRAMMER,
G. V. FOX,
DARWIN E. WARE,
RICHARD FROTHINGHAM,
P. EMORY ALDRICH,
F. W. LINCOLN,
R. T. DAVIS.

Mr. Warren Sawyer has been prevented by illness from acting with the Commission.

REPORT OF PHINEAS BALL, CIVIL ENGINEER, TO THE COMMISSION.

To the Joint Commission "for the abatement of a nuisance in the Lower Basin of Miller's River, and for the Preservation of Health in the Cities of Cambridge and Somerville."

GENTLEMEN :—Having been appointed by your Honorable Board to make surveys of said District, and estimates of permanent improvements therein, which shall abate, or aid in abating said nuisance, as contemplated by Chap. 353 of the Acts of the Legislature for the A. D. 1872, and having performed the duty assigned, the following Report is respectfully submitted, to wit :

Associated with this Report, partially explanatory thereof, is the accompanying map, compiled from the maps of the Cities of Cambridge, Somerville and Charlestown, illustrative of the River and the water shed draining into it, showing, also the sewers, now built by Cambridge and Somerville in said Basin and emptying their contents into the River and its several Basins.

A brief description is first given of the several parts of Cambridge and Somerville, the surface water of which originally drained into the River and Basins.

CAMBRIDGE WATER SHED.

The portion of Cambridge naturally draining into this River, at its eastern extremity, commences on Bridge street, nearly at its intersection with Gore street ; thence passes westerly along the summit of the hill to Cambridge street ; thence southwesterly, nearly in a right line to the intersection of Elm and Hampshire streets ; thence to the intersection of

Prospect street and Broadway ; thence running southerly to the intersection of Inman and Austin streets ; thence passing westerly to the summit of Dana Hill ; thence passing westerly, including about 3-4 of college square, and a portion of the Common ; thence turning in a northwesterly direction, running to the summit of the hill at Washington Avenue ; thence turning and running northeasterly to the southerly line of Somerville, near Porter's station on the Fitchburg Railroad ; thence turning easterly and following the southerly line of Somerville to Bridge street, as first above stated.

The foregoing is a general outline of the area in Cambridge naturally discharging its waters to the sea by the way of Miller's River and its Basins, and includes a territory of about 400 acres, or about one-half that of the Somerville water shed.

For the drainage and sewage of the territory lying westerly of Webster avenue in the City of Cambridge, there has been provided by said Cambridge, outlets into Charles River as follows : one at Bath street, one at College wharf, and one for the Oxford street sewer, and one at Front, Main and Hampshire streets respectively, so that no sewage in this portion of the District need be carried hereafter into the Miller's River.

For the sewers along Webster avenue and easterly of it, the City of Cambridge has now the following sewer outlets into Miller's River Basin, to wit : one at Bridge street, one at Fifth street, one at Gore street, and one in common with Somerville, at the Oak street outlet.

These four outlets discharge the sewage from 12,205 feet of sewers, or 2.31 miles.

In addition to the public sewers there are some private drains into the basins.

Formerly there was an outlet into an arm of the stream from Kirkland street, but this has long since been discontinued, and by connecting sewers been diverted into those discharging into Charles River.

The City of Cambridge has just completed the building of a $5\frac{1}{2}$ x 5 foot brick sewer in Ninth street, from Cambridge street to Broad Canal, and made a connection between this Ninth street sewer and the system of sewers lately discharging into the Squire Basin, by an outlet at the Grand Junction Railroad; by this means, turning their contents into Broad Canal, and thence into Charles River.

An extension of this Ninth street sewer to Gore street, and by rearranging a portion of the Fifth and Winter street sewer, so that the Bridge street sewer may be passed through Fourth street to Winter, then all sewers now discharging by the Bridge, Fifth and Gore street outlets, may be turned into this Ninth street sewer, and all outlets into the Squire Basin be thereafter discontinued.

The Cambridge sewers now connected with the Oak street outlet, have other connections with sewers running to Charles River, and so arranged that at any time when it becomes necessary, the portions now running into the Somerville territory may be separated from said Somerville, and turned off into Charles River, thereby relieving the Upper Basin of Miller's River of the presence of the sewage, thus providing for it wholly on territory in the City of Cambridge.

When the improvements contemplated in the construction of the Ninth street sewer shall have been completed, and those changes referred to in connection with the Oak, Fifth, Gore and Bridge street outlet shall have been made, then no drainage water or sewage matter from the City of Cambridge lying within this area, will be conveyed by sewers into Miller's River.

This arrangement of the Cambridge sewers relieves said city of all responsibility, so far as sewers are concerned, in the matter of the Miller's River nuisance.

The Plan by which it is accomplished aids the solution of the remaining problem as it is related to Somerville, for it reduces by about one-third the drainage area that would be

carried out into deep water by a single outlet, had it all been retained to be carried down its natural valley.

SOMERVILLE WATER SHED.

The eastern extremity of this basin rests upon Miller's River, and is bounded southerly by the northerly line of Cambridge running westerly as far as the point where Beacon street intersects Milk street; thence passing northerly to Cherry street at Elm; then running northeasterly and easterly to and along the summits of Spring, Central and Prospect Hills; passing from Prospect Hill along Highland Avenue to Medford street; and thence to Washington street; and thence diagonally to the Boston and Lowell Railroad; thence along said Railroad to Miller's River. This area may be termed the Milk street District.

Upon the north side of the northerly boundary of this area, extending for most of the way over to the Boston and Lowell Railroad, and running westerly as far as Jenny Lind street, there is an area whose waters are brought down into this Basin by the gutters by the side of said Railroad, to Washington street, and are carried thence to Miller's River by a culvert or sewer, running from Washington to Linwood street and thence by a sewer, via Linwood and Poplar streets, and crossing Milk street into the Basin at the foot of Poplar street.

The areas of these two territories are as follows :

	Acres.
Area of Milk street District,	680
Area along the Boston and Lowell Railroad,	75
Total,	<hr/> 755

Lying northeasterly of the above districts are two other portions of Somerville that belong to the lower Basins of the River, above Prison Point Bridge, as follows :

Easterly of Washington street extending to the town line, and including the McLean Asylum estate, and the flats occupied by the Railroad companies, comprising an area of 175 acres, and one on the westerly side of Washington street,

running up to the water shed line and Cross street, there is an area of about 50 acres, making a total area of 225 acres of the present Washington street district.

From this district northeasterly of Cross street, about 150 acres have been separated by an arrangement of sewers which conducts its drainage into the Mystic River, by the way of Cross and Marshall streets.

The entire Somerville territory may be summed up as follows :

	Acres.
Milk street District,	680
Boston and Lowell Railroad,	75
Washington street,	225
Turned off above Cross street,	150
Total,	1130

An area equal to 42 per cent of the whole territorial limits of the city of Somerville, that being 2694 acres.

Of this district 980 acres still find an outlet by the original channel at Prison Point.

CHARLESTOWN WATER SHED.

In the city of Charlestown, southerly of Canal street up to Somerville line, there is 110 acres, and on the northerly side of Canal street up to the water shed line, there is about 150 acres which belong to the same water shed Basin.

Thus the area drained originally by the outlet at Prison Point Bridge was as follows :

	Acres.
In Cambridge,	400
In Somerville,	1130
In Charlestown,	260
Total,	1790

New drainage outlets for this territory must be provided for main sewers, in Somerville and Charlestown, as fast as improvements now being carried on, and in contemplation, require their construction.

In fact, before these many improvements can be perfected, and business, private enterprise, and the local inhabitant, reap the full advantage that is possible to be derived from these various contemplated betterments, the present natural outlet of this drainage must be replaced by one or more artificial ones.

THE CAMBRIDGE SECTION.

As has been before said, the City of Cambridge has so arranged its system of sewers, as to be at present draining her portion into Charles River, excepting about 60 acres at the easterly end of it, and for this 60 acres the plan has already been devised and nearly completed, by which the drainage of this, too, may be carried into Charles River, as soon as improvements may demand it.

THE CHARLESTOWN SECTION.

Upon that area lying northeasterly of Canal street, ample sewers are now in successful operation, which have their several outlets into the Mill Pond, so called, and the basin below, near the State Prison. Whenever the Mill Pond shall be filled by the Railroad companies, as now contemplated, then new outlets will have to be made for these sewers, either through the new filled land, or else by new routes along Canal and other streets, to tide water in Charles or Mystic Rivers.

THE SOMERVILLE SECTION.

This section may be properly divided into the Milk street, and Washington street divisions.

The Milk street portion is 11,200 feet, or 2.12 miles in length, from east to west, along Milk and Elm streets, and has as a greatest width from north to south, a distance of about one mile, covering an area of 755 acres.

Upon this territory Somerville has now constructed 64 streets and portions of streets, having an aggregate length of 75,900 feet, or 14.37 miles, and covering an area of 3,335,680 square feet, or 76.59 acres.

In 20 streets there has been 39,944 feet of sewers, heretofore built, or now in process of construction.

These several sewers have four outlets, one into the River at Dane street above the Union Tube Works; one for the Oak street system into the Upper Basin, near the Union Glass Works; one at Poplar street on the south side of Milk street into the Basin just below Medford street; and one into the River near the head of tide water, in Prospect street.

This last is the outlet of the Milk street sewer, and is by far the most important of all the outlets, as it now delivers the drainage from 22,500 feet, or 4.24 miles of sewers, into upper tide water at this point.

The Milk street main has been laid along the line of said Milk street and Elm, from Prospect to Cherry street, a distance of 7502 feet, or 1.42 miles.

From Prospect to Spring street, a distance of 4682 feet, the sewer is three feet in diameter, and has a uniform inclination of two inches to the 100 feet, and a consequent rise of 7 feet 9½ inches between these two points.

This is the main sewer for the western and northern portion of this territory, and drains about 325 acres. With this sewer there is now connected 14,798 feet, or 2.80 miles of sewers.

Lying southerly of Milk street and westerly of Prospect is an area of about 215 acres, mostly drained directly by the channel of the River.

Southerly of Milk street, and easterly of Prospect, there is an area of about 93 acres, including all tide water Basins lying within its limits. In these two areas there are only 7678 feet, or 1.45 miles of sewers now built and under contract.

Lying northerly of Milk, and easterly of Washington street, is an area of fifty acres, with only the Poplar street outlet, representing 4680 feet of sewers, and in addition to its own area, draining the surface water from 75 acres by the side of the Boston and Lowell Railroad westerly of Washington street.

The Milk street Sewer is so located as to intercept, control, and convey to tide water, all surface drainage, and sewer water on the 325 acres lying along, and to the northerly of it.

The drainage of most of the territory lying southerly of Milk street, and westerly of Prospect, is still cared for by the channel of the stream. This channel may be said to leave the upper Basin below the Union Glass Works, and run thence by various windings, a distance of one thousand feet, to a point on Prospect, about one hundred feet westerly of Milk street, and thence in a very circuitous westerly and southerly direction, crossing Webster avenue and passing directly under the Methodist Church, on the southwesterly side of Webster avenue; thence southerly, passing under the Fitchburg Railroad, turning westerly, crossing Washington street; thence running northwesterly to the southerly side of said Railroad; and thence following said Railroad to a point where it turns southerly, on the easterly side of Reitenbach Bros. and Mink curriers shop, and runs out to Beacon street, where the head of the stream may be said to be.

From Prospect to Washington street, there are culverts on the line of the brook now built, four of which have the following sectional area.

The one under the Methodist Church,	10 sq. ft.
Under the Fitchburg R. R. west of Church,	8 sq. ft.
Under Washington street,	10½ sq. ft.
Under Prospect street, 3.5 x 5,	17.5 sq. ft.

The rise in the stream and distances thereon are as follows :

Points at which levels were taken.	Above Mean Low Water.	Distance from upper Basin at Culvert, under Fitchburg R.R.
Prospect street,	Tide Water.	1000
North side Washington street,	10.95	2653
American Tube Works,	12.32	3700
Middlesex Bleachery,	14.71	5270
Reitenbach & Bros. and Mink cur- riers shop,	16.32	6313
Beacon street,	16.34	6679

Thus it will be seen that this stream has a very slight rise being only 6.34 feet above mean high water, at its source nearly a mile from Union Square.

On the south the water shed line in Cambridge has its highest summit on Dana hill at an elevation of 46.3 feet above mean low water, Harvard Square being 37.8 feet; while on the northerly line of the water shed in the Milk street District, in Somerville, the elevation above mean low water is as follows, at points as named, to wit:

At the junction of Medford and Highland Avenue,	74.0
At Hamlet street and Highland Avenue,	78.7
At Thorp place,	84.8
At Walnut street,	87.7
At Vinal Avenue and Highland Avenue,	101.4
At Putnam street and Highland Avenue,	103.5
At Prescott street and Highland Avenue,	103.0
At City Hall in Highland Avenue,	105.4
At summit near Central in Highland Avenue,	120.0
At Central street and Highland Avenue,	97.1
Spring Hill at Belmont street, near Baptist Church,	140.0

In the Washington street section, which covers an area of 225 acres, there are 14 streets and parts of streets, having an aggregate length of 9675 feet, the streets covering an area 445,150 square feet.

There has been built in this section during the present season, 5086 feet of sewers, the outlet of which is in Waverly street, at 8.23 feet above mean low water. This outlet is 4270 feet from Prison Point Bridge.

When the five Railroad corporations, and the McLean Asylum, now owning the most of said flats, shall have filled them and obliterated the present water courses, a new outlet will have to be devised for this Waverly street sewer, and if no other or better outlet can be secured, this main will have to be extended at least as far as the Fitchburg Railroad Dock above Prison Point Bridge, a distance of about 3660 feet, and, if so extended, will carry out the drainage northerly of

Washington street, with most of that upon the flats southerly of it, covering an area of about 225 acres.

The ultimate drainage however, of this section south of Washington street, may be effected by one or more outlets for smaller sewers, at intervals along the Fitchburg Dock, beside the one main drain as above proposed.

N U I S A N C E .

Having given a general description of the outline and position of the several portions of the Miller's River drainage area, as related to each other, and to the Cities of Cambridge, Somerville and Charlestown, which description will be the more readily understood by the aid of the accompanying map, and having also pointed out, in brief, the location of the outlets of the sewers therein, before further developing the subject of disposing of that sewage, a few considerations will be devoted to the nuisance which now exists in the Squire and upper basins of the Miller's River.

That one exists is apparent to the senses, especially when the tide is out.

In localizing or tracing out the nuisance, several examinations of the basins above and below Medford street have been made when the tide was out, and also when the tide was at its flood, and some observations upon the action of those tides upon the material exposed in the basins at ebb tide, and upon the sewage turned into them from the several sewers whose outlets are in the upper basin.

The distance from the head of the upper basin, near the Union Glass Works, to the Boston and Lowell Railroad over the river below Milk street, is about 4000 feet, and Prospect street, where the larger amount of sewage is now discharged into the tide, is about one mile from said Railroad. From the Lowell Railroad to Prison Point Bridge is about 3000 feet, so that from Charles River below Prison Point Bridge to Prospect street, is nearly two miles.

The largest amount of sewage matter from sewers, comes to tide water at the junction of the Miller's River with Pros-

pect street. This point as below stated, is nearly at head of tide water, and 1000 feet from the upper basin.

Here the stream has been contracted by walling, to meet the improvements on the adjoining estates, to a width of about five feet.

The quantity of water flowing in the stream is quite various at different times.

At three separate dates the flow of water was as follows :

1872.	Cubic feet per second.	Cubic feet per hour.	Cubic feet per day.
Oct. 2.	3.20	11,520	276,480
“ 18.	1.95	7,020	168,480
“ 30.	0.66	2,376	57,024

The waters of the stream itself are highly laden with sewage matters, doubtless mostly from the refuse of the Middlesex Bleachery.

The several basins above Milk St., contain areas, and average depth of mud as follows :

Basin.	Square feet.	No. of Acres.	Depth of mud in feet.	Cubic feet of mud.
Squire,	655,650	15.00	2.7	1,770,255
West of Medford St.	102,830	2.30	2.2	226,226
N. of Fitchburg R. R.	141,380	3.20	3.1	438,278
Upper Basin,	311,000	7.10	3.0	933,000
North & Merriam,	19,240	0.44	2.3	42,328
Totals.	1,230,100	28.04		3,410,087

By ordinary tidal action all basins above Prison Point Bridge become settling Reservoirs for the suspended materials brought by the flood tide from Charles River, and also of such precipitable sewage matters as are brought to them from all other sources.

This action is undoubtedly materially modified by the filling across the river for the streets and Railroads, leaving only narrow passages under them from basin to basin. One evident result of these contracted waterways is, to largely increase the velocity of the incoming and outgoing water, at each point where they are located, which increased velocity

disturbs and agitates the lighter sediment, transporting it readily from basin to basin, and naturally forcing the larger amount of this sediment into the upper basins, as is indicated by the increased depth of mud therein.

Upon the sewage delivered to the upper basin south of the Fitchburg Rail Road from the Sewers and other sources, the direct action of the tides is to confine it in the basin south of the Fitchburg Rail Road and force it to deposit its precipitable matters there, taking the soluble matters alone in its course to Charles River.

In this manner these basins not excepting the Fitchburg Rail Road Dock become cesspools for the collecting, storing and decomposing of sewage matter and offal coming to them from whatever source.

The small quantity of water brought to these basins by the stream has no influence in aiding the cleansing of any one of them by forcing the sewage out to deep water. The daily average throughout the year estimating 50 per cent of the rainfall to be drained off would amount to only about 35,000 cubic feet during a half tide, or a quantity only sufficient to raise the upper basin in 6 hours only 0.11 of one foot, a quantity utterly insignificant as a cleansing power over the basin into which it empties.

On many days in the year during severe storms and freshets, a very much larger quantity of water is brought down than this average, but even in its most powerful condition it is not possible for it to produce any decided cleansing effect, upon any one of the basins.

Their expanded area simply become the precipitating reservoirs of such suspended waters, as are held in the waters of the stream.

The tides as they flow and ebb in the basins, present an appearance of water largely defiled, but on sampling, as compared with its looks while in motion, its aspect is relatively clear. Its repulsive appearance in the stream is produced mostly by a reflection from the bed over which it moves,

The several basins above Milk street when the tide is out, present a repulsive spectacle, and emit a foul, offensive and sickening odor.

As far as observed this pungent, nauseating stench, nearly disappears at high tide.

To every inquiry made of those most accustomed to pass on Milk street, the reply invariably came, that this stench was much the most severe when the tide was out.

To trace this stench to its elements, and ascertain its peculiar nature, by the advice of the Secretary of the State Board of Health, samples of this mud were taken and submitted to chemical analysis, also samples of water taken at Miller's River Bridge, below the Squire basin, and at Prison Point Bridge, with a view to ascertain what influence the substances held in the mud had upon the purity of the water.

These several samples were analyzed by Prof. C. O. Thompson, President of the Technical School at Worcester, his Report of which analyses is as follows. ;

Laboratory of Worcester Technical School.

HON. PHINEHAS BALL,

Dear Sir: I beg to submit the following report on samples of mud and of water from certain streams and basins in the City of Somerville, Mass.

Preliminary examinations indicated the presence of ammonia and sulphur compounds.

Determinations of free and potential ammonia in eleven samples—numbers corresponding to your own—were made, with results as stated in the table.

AMMONIA DETERMINATIONS.

PARTS IN A MILLION.		Samples.	Free.	Potent'l	Total.	Tide.	Locality.
		No.					
Water.		No. 15	1.76	3.44	5.20	Ebb.	Miller's River Bridge.
		" 16	.80	1.84	2.64	Flood	" " "
		" 17	1.00	1.78	2.78	Flood	" " "
		" 18	1.80	3.49	5.29	Ebb.	" " "
		" 19	.72	.93	1.65	Flood	Prison Point Bridge.
		" 20	.42	.87	1.29	Ebb.	" " "
Mud.		" 3	312	4940	5252		Squire's Basin.
		" 31	238	2912	3150		" "
		" 4	82	1479	1561		Upper Basin.
Water.		" A	16	2.61	2.77		Stream above Prospect St.
		" B	12	2.77	2.89		Stream below Prospect St.

Determinations of sulphur as hydrogen sulphide, were made in samples No. 3, and No. 32—mud from Squire's basin, with the following result :

No. 3 yields one cubic foot of hydrogen sulphine gas from 216 pounds of mud.

No. 32 yields one cubic foot of hydrogen sulphide gas from 233 pounds of mud.

In each case the sulphur compounds were decomposed at the temperature of boiling water, and the amount estimated in the mud in its natural condition. The volume of gas is reckoned at the standard pressure and temperature.

Certain conclusions may be drawn from these facts.

The amount of matter capable of producing ammonia in the Miller's River Bridge water is about twice as great at *ebb* tide as at *flood*, and about four times as great in ebb tide at this place as at Prison Point Bridge. Hence these basins at Miller's River must receive from some source a large quantity of nitrogenous matter.

The production of hydrogen sulphide or any of its ammonia compounds at the temperature of boiling water, shows that the sulphur could not have been derived from inorganic sulphates.

The potential ammonia comes from urea and albumen, mainly from the latter, since in 19, 20, A, & B, no urea was found.

The quantity of albumen is unusually large. In the mud, No. 3, for instance, there are 4940 parts in a million of potential ammonia; that is, in this mud there is albumen enough to furnish, in decomposing, the nitrogen required for 4940 parts of ammonia to a million parts of mud.

To show by comparison the remarkable character of this result, I will ask you to notice that the water of the river Irwell, which drains the City of Manchester, England, shows, *above* the city, nitrogen equal to 1.23 parts of ammonia in 1,000,000 of the water; *below* the city after receiving all its sewage, it shows 42.6 parts in 1,000,000.

Now if the contents of the basin from which No. 3 was taken, were pure albumen, its decomposition would show 147.887 parts per million of ammonia. Hence this analysis shows that the mud must contain 3.3 per cent of albumen.

Again, the presence of sulphur under the conditions just enumerated, indicates that the albumen is mainly furnished by blood-serum of which sulphur forms from 1.3 to 1.9 per cent. This view is confirmed by a comparison of the ammonia and sulphur determinations, thus:

The albumen in No 3, should give by Liebig's Formula, 419.7 pounds of sulphur to 1,000,000 pounds of mud. The amount of sulphur due to hydrogen sulphide *found* in No. 3, is 414 pounds in 1,000,000.

The dismissal into the atmosphere of such quantities of ammonio-sulphur compounds, cannot but be highly baneful. 216 pounds of the mud from the Squire's basin would poison 1500 cubic feet of air by its exhalations so that birds could not live in it, 800 feet so that dogs could not live in it, and 200 feet so that horses could not live in it.

Were the purifying agencies of tide and winds removed, the neighborhood must soon become uninhabitable.

In my opinion, an overlying stratum of sand and gravel, six feet thick would not prevent the escape of noxious gases, nor is it safe for men to work at dredging the basin when the temperature is much above the freezing point, unless the basin is kept constantly flooded.

(Signed.)

C. O. THOMPSON.

The samples of water were made by taking a fixed quantity of water every twenty minutes during a half tide, and thoroughly mixing the whole amount thus collected.

Samples of mud No. 3 and 4 were taken from a mixture of 24 equal small quantities taken from as many different points of the basin, and thoroughly mixed.

No. 31 and 32 were samples taken at separate points, and as a whole from each selected location.

THE DRAINAGE QUESTION.

By the foregoing statements two facts are apparent.

FIRST,—That these several Miller's River basins by the arrangement of the system of sewers in the City of Somerville, are the receptacle of all their contents, and the depositories of their filth, and by reason of their position and the location of business upon their borders, they are the natural receptacle of all sewage material produced by that business lining their shores.

SECOND,—That, by this action, these basins have become a source of great nuisance to the immediate neighborhood, which nuisance will be indefinitely continued so long as they are treated as the legitimate outlets of the drainage and sewage of this territory to tide water.

It follows then as an inevitable result that the first step in the renovation, or preservation of any one of the basins above the Boston & Lowell Railroad, can only be secured by

the construction of proper artificial sewer and drainage outlets, which shall act effectively in place of present natural one.

As soon as these new drainage channels with all the necessary laterals, are provided by the City of Somerville, the water areas of the basins assume at once new relations.

The cause of the nuisance proceeding therefrom as related to the corporation ceases, and at the same time that the corporation has abated its own nuisance, it has provided the individual occupant along their shores and in the vicinity, with the complete means of abating their own, so far as that can be accomplished, by drainage.

In a general survey of the ground covered by the question, one conclusion forces itself into prominence, and that is, that no final disposition, satisfactory to all business interests, and the inhabitants and occupants of the district between Union Square and Charles River, following the line of the basins, can be made until this drainage and sewage is carried out to deep water.

All measures short of this are only partial and temporary, serving only a limited purpose during the period of their existence previous to their being carried out to deep tidal currents.

The question of vital importance presented being the one relating to drainage, it has been studied with special reference to its extent and in its relative bearings. No aid tending to a solution of this difficulty can be obtained from the ebb and flood of the tide in the basin, or the flow of the water in the stream.

Before the appropriation of this drainage area to the purposes of business, and the dwelling place of a thriving and populous community, the normal action of the River was sufficient for its drainage.

The creation here of a populous community with its many attendant industries has transformed what was once a healthy creek into an offense and a nuisance. The creating

cause is artificial. It comes of the manner of appropriating the soil, and the mode of using it.

As the cause is artificial so must be the remedy ; and this remedy must be adapted to meet the wants of this altered condition in the use and occupancy of this territory.

The relief must be so applied, as not only to correct the present existing evil, but also to place the space now suffering from these joint causes, in such a state of renovation that it may answer any requirements which business, trade or habitation may make upon it.

As before stated, Somerville has constructed a main sewer which now enters tide water at Prospect street.

By an inspection of the map it will be seen that this point is important, as the initial point of the continuation of the main sewer to deep water. Its present outlet is 8.8 feet above mean low water, or 1.2 feet below mean high tide, therefore all progress to the sea in whatever direction, must be entirely within the tide.

One other fact common to any line out to deep tide is, that such is the general evenness of the country to the east, and northerly, and southerly of this point, that several feasible routes may be taken for the outlet, each possessing some distinctive feature of its own, but not one of which would be rejected were it the only available line.

The location of these several lines with the length of each is as follows :

From Prospect Street, in Milk Street, to Miller's River below Squire's basin, 3856 feet ;

From Prospect Street to Cragie's Bridge by Milk Street in Somerville and Bridge Street in Cambridge, 7010 feet ;

From Prospect Street, in Milk Street to Medford Street, in Medford Street to Gore Street in Cambridge, in Gore St. to Bridge St. and in Bridge St. to Cragie's Bridge, 7300 feet ;

From Prospect Street to Webster Avenue, in Webster Avenue to Bristol Street in Cambridge, and Bristol and Potter Streets to Charles River, 8750 feet ;

From Prospect in Milk Street to Fitchburg Railroad, and beside the Fitchburg, and Boston and Maine Rail Roads to Charles River, 1000 feet; below Prison Point bridge, 8040 feet;

From Prospect Street to Fitchburg Railroad and by the Fitchburg Railroad to Front Street in Charlestown and by Front Street to Warren Bridge, 9555 feet;

From Prospect Street to Washington Street, and in Washington street to Cambridge street in Charlestown, and thence by Cambridge street in Charlestown to Mystic River at Tuft's Wharf, 6350 feet;

Summary of distances to the several outlets from Milk street at Prospect street.

No. 1.	Potter street, in Cambridge,	8750 feet.
No. 2.	Cragie's Bridge via Gore street,	7300 feet.
No. 3.	Cragie's Bridge by Milk & Bridge,	7010 feet.
No. 4.	Prison Point Bridge,	8040 feet.
No. 5.	Warren Bridge,	9555 feet.
No. 6.	Tufts' Wharf on Mystic River,	6350 feet.

No one of these several lines lies wholly within the City of Somerville.

No. 1 is 6750 feet in Cambridge.

No. 2 is 4340 feet in Cambridge.

No. 3 is 3154 feet in Cambridge.

No. 4 is 1600 feet in Charlestown.

No. 5 is 3700 feet in Charlestown.

No. 6 is 2550 feet in Charlestown.

Nor is it possible to construct this main drain by any line to deep water entirely within the limits of the City of Somerville.

The general characteristic of the several routes may be thus stated.

No. 1. By way of Broad Canal, the profile line is very uniform, commencing at grade 15.3 at Prospect street, and in no place rising above 17.8 feet above mean low water, presents no obstacle whatever to the successful building of the desired sewer.

Tide water at the head of Broad Canal may be reached in 5000 feet, but to deliver the sewage here seems so objectionable, that this course could not be entertained as worthy recommendation, since this point is some 3750 feet from the Harbor Commissioners line in Charles River, and by a canal only eighty feet wide in its walling, forming an arm of the river, so situated as to be quite certain to perpetuate the very same nuisance on Cambridge soil, which it would abate upon that of Somerville.

If then this route should be chosen, no alternative would be left, in order to escape all consequences of this kind, but to carry the line intact to the river, avoiding the canal from the very first, and then in building here, from 1400 to 1700 feet additional sewer would have to be built over that of less objectionable lines, without reaping a single apparent advantage over that presented by Nos. 3 & 6.

Line No. 2, by the way of Gore street, has nearly the same profile line of No. 3, excepting the summit at Gore and Third streets is 8 feet higher than the summit of Bridge street.

This line is 290 feet longer than line No. 3, and the only advantage which it appears to present over No. 3, is that it can be constructed at once to Charles River, and leave the Squire basin intact, draining from it all the sewage matters now conducted into it.

Lines No. 3 and 6 will be considered in comparison.

Lines No. 4 and 5. On each of these the profiles are uniform and nearly level, and not above grade 16. Their route is a common one to Prison Point Bridge, where the outlet must be until such time as the basins northerly of the Fitchburg Railroad are filled so that the sewer can be carried into Front street in Charlestown.

To deliver the contents of the sewers from nearly 1000 acres of a thickly inhabited city as Somerville will be in a few years, into the foot of the Fitchburg Railroad Dock, above Prison Point Bridge, is not a large improvement over turning it into the head of the Dock below Milk street.

One more serious objection is, that as a matter of construction, a main sewer laid beside the Fitchburg Railroad, and under two or three other Railroads, would be wholly upon private property, and in a location which largely partakes of a public nature, especially as related to business.

By the side of a Railroad, and over ground appropriated to its business, the care of the sewer would be a source of annoyance to that business, and an inconvenience in case of repairs, which should not be assumed in selecting a location, without the strongest reasons in its favor to overbalance the objection.

One other objection of more importance, is that the foundation on which it would be necessary to rest the sewer is unsafe for about 2000 feet from Prison Point Bridge, without recourse to piling. The constant vibration caused in the earth by the passing of Railroad trains, would make any structure, upon even a foundation of piling, of either wood, stone or brick, or any combinations of them, much less permanent than is desirable in a trunk sewer of such size, and of such importance.

Lastly is to be considered lines No. 3 and 6. The first by way of Milk street in Somerville, and Bridge street in Cambridge, to Cragie's Bridge.

The other by Washington street in Somerville, and Cambridge street in Charlestown to Tufts' Dock.

Of these two lines complete profiles have been made. The following is a summary of the grades on each, with the cuts required to commence a sewer at low water, and run it up to grade 6 feet above mean low water at the end of Milk street sewer, at Prospect street in Somerville.

FIRST, MILK AND BRIDGE STREET LINE.

Designation of Point.	Elevation of surface above mean low water.	Cut for Sewer.
At Cragie's Bridge,	15.47	16.47
Prison Point Bridge,	17.26	18.02
Cambridge street,	16.58	16.67
East street,	17.27	17.19
Gore street,	24.79	24.35
Summit,	26.50	26.00
Third street,	21.63	20.59
Fourth street,	14.06	12.59
Miller's River Bridge,	15.20	13.50
Fitchburg Railroad,	15.91	13.29
Medford street,	14.48	10.73
Prospect street,	15.24	10.24

SECOND, WASHINGTON AND CAMBRIDGE STREET LINE
TO MYSTIC RIVER.

Designation of Point.	Elevation of surface above mean low water.	Cut for Sewer.
Tufts' Dock,	13.33	14.33
Main street,	18.16	18.95
Canal street,	18.66	18.95
Perkins street,	17.70	17.70
Railroads,	17.98	17.70
Summit near Carter street,	19.51	18.75
Pinckney street,	15.59	13.99
Franklin street,	19.00	16.55
Tufts street,	20.58	17.51
Under Boston & Lowell R. R.,	13.96	10.75
Medford street summit,	29.21	25.44
Mystic street,	22.26	20.44
Washington at Prospect street,	18.81	14.00
Milk street at Prospect,	15.34	10.24

The foregoing profiles are all that have been made, as they seemed the only important ones.

The superficial area of the profile section, from the surface to the grade line proposed for the base of the sewer in the Milk street line, is 105,036 sq. ft.

In the Washington street, 111,670 sq. ft.

Difference of 6,644 sq. ft.

representing a cubic capacity of 242 cubic yards, and for a trench 10 feet in width, a difference of 2420 cubic yards, or the Milk street line contains about 94 per cent as much excavation as the Washington street line, while in length the Washington street line is a little less than 90 per cent of the Milk street.

After this summary of facts it is recommended that the two territories in Somerville belonging to Miller's River drainage area, and Prison Point Bridge basins, comprising the Milk and Washington street districts, be drained by a main sewer, laid from Milk street at Prospect street, through Prospect to Washington street, and in Washington street in Somerville, and Cambridge street in Charlestown, into the head of Tufts Dock on Mystic river. For the following reasons:

First—The distance is less than by any other line. The outlet will be near the tail race of Tufts' Mill, and so long as the mill shall continue to be used, the contents of the sewer will be effectually swept out to the tidal currents of the river.

Second—Whenever Tufts' Mill Pond is disused, the sewer can be extended 1000 feet to the end of the wharf, and then its contents will be emptied directly into the deep water currents of Mystic River.

Third—This arrangement takes the main sewer outlet from one of the prominent and leading thoroughfares into the City of Boston, and places it in one less frequented, thereby rendering its care and maintenance freer from annoyance to a larger number of persons who use the street for business or travel.

Fourth—The mouth of the sewer is taken away from a point in or near a crowded thoroughfare, and placed in a Dock,

or ultimately at the end of a wharf, thereby subjecting few persons to sewer gasses, more or less of which will escape from a sewer of this magnitude during low tide.

Fifth—This outlet aids the dispersion of sewage in tide water, as at present far more drainage and sewage is turned into the Charles River than into the Mystic; for by the ninth Report of the United States Commissioners on Boston Harbor, for the year 1865, the Mystic River when improved to the Harbor Commissioners lines, is reported to have a tidal volume of 663,595 cubic yards of water over that of the Charles River, when improved in the same manner.

The Charles River receives and conveys to the Ocean this polluted material through a space between Cragie's Bridge and Charles River Bridge, a distance of about a half mile, in which are eight bridges, over which water area more business is done, and a larger amount of travel passes than over the same space of water area at any point around Boston; and any means by which the water passing in and out through this channel can be kept reasonably pure, must be a public benefit, and warrants the expenditure of a reasonable amount of means to accomplish, or even aid an object so desirable.

Sixth. The drainage of the flats lying easterly of Washington street and southerly of Milk, can be as efficiently done by this line as by any other, because most of the lateral drains will lie under tide water, a fact which is common to the laterals of any route which may be taken from Prospect street to tide water, and as the corporation of Somerville is protected in its public improvements by the grade act, Chapter 299 of the Acts of 1872, which Act provides that no cellar shall be built upon these flats below grade 13 above mean low water, except under certain regulations, which regulations being within the control of the Mayor and Aldermen, leaves the city ample latitude for the proper arrangement of such sewers as are hereafter built upon these flats.

Seventh—This arrangement of the main outlet sewer, places all basins above the Boston and Lowell Railroad in

such relations to drainage, that they may be filled and used as solid ground, whenever the interests of business and the community can be best subserved by so doing.

Eighth—This location takes all public outfall sewers from the Railroad grounds between the Grand Junction Railroad and Prison Point Bridge, thereby leaving the five Railroad Corporations, to the construction, care and maintenance, jointly or separately, of their own drains, in any form, and by methods best suited to their convenience or business.

Ninth—This line is believed to present the best ground in which to build a sewer, no portion of which appears to be marsh mud, a feature not presented by a single other line in its whole length, and one guaranteeing increased permanence to the structure.

Tenth—Should at some future day engineering or sanitary science perfect and successfully adopt a mode of utilization of sewage, economical and effective, the location in Washington street is evidently better adapted to the application of any such method, than that of any other line presented.

Eleventh—The Milk street line can only be built to the Squire basin so long as this basin shall be retained, and during the discharge of the contents in this location, the sewage nuisance will be continued in it and the Fitchburg Railroad Dock.

FUTURE SEWER CONNECTIONS.

The connection for the necessary sewers southerly of the Fitchburg Railroad, would naturally be made by one of suitable size laid in Washington street, and extending through Union Square to Prospect street.

The Oak street system could be extended through Webster Avenue and be connected with the Washington street line, without rearrangement of its grades westerly of Prospect street.

The elevation of the Oak street sewer at Prospect street is 7.6 above mean low water, which would give a fall

of about one foot from Oak street to Union Square, in the Webster Avenue main, in a distance of about 1400 feet.

In Milk street a sewer might be run from near Medford street, a distance of 1400 feet, which would take the connecting laterals back to Prospect Street.

A sewer in Medford street from the city line to Milk, might be continued direct to Washington street, and answer as a main for connecting streets, or it might be turned through Milk street into Poplar street, and through Walnut to Joy street, and thence by Joy street to Washington street as a main sewer for that part of the district below Medford street, and one in Milk street being extended from near the bridge, below the Squire basin, through Milk and Linwood streets to this main at Poplar street.

The greatest length of these lines, in any one direction, would not exceed 3600 feet.

The grade of the Washington street main at Joy street would be 4.4 feet, and this would allow all this system to be laid with grades running under 9 feet, giving larger inclinations throughout, than that of the main sewer, which is nearly one foot in 1000 feet, a grade somewhat larger than that now being used by the City Engineer of Cambridge, J. P. Chase, Esq., in similar locations, that being six-tenths of one foot in one thousand feet or nearly 7 1-4 inches.

In this arrangement the sewer now laid in Poplar street would need rearranging, as its outlet is 5.60 feet above mean low water.

The necessary sewers easterly of Washington street, down to the Grand Junction Railroad, including the McLean Asylum estate, can properly come to this main. The elevation of the summit of the Asylum estate being 62. The larger part of the drainage of Charlestown, now turned into the Mill Pond, could find an advantageous outlet through this channel by way of Canal street.

TIDE GATES.

This sewer may be used with or without the ordinary tide gates to shut out the tide, or a modification may be ar-

ranged for flushing purposes, either at the mouth or at any point in its length, which may be closed by hand by the Superintendent of Sewers, or other person in charge, at any height of the incoming tide, and when the tide is out hoist these gates quickly, and in this manner a flushing power in the sewers would be obtained by a force superior to that produced by an ordinary ebb tide.

Excluding the tide by gates possesses very indifferent useful results in an outlet so large and controlling a system so extended as the one under consideration.

The size sufficient in drainage capacity will have little value, as a reservoir, to hold storm water during high tide. The area of streets in the Milk and Washington districts is 4,161,780 square feet; an inch of rain fall in an hour upon the surface of the streets alone, would give 346,815 cubic feet of water, a quantity a little larger than the capacity of the main line as proposed in Washington street.

Thus during storms the gates must be forced open to let out accumulating water.

Two tables are added, number one giving the quantity of water that can be stored in the main sewer, and number two the quantity of water produced by one inch of rainfall upon the Milk and Washington street districts.

NUMBER ONE

Feet of Sewer.	Diameter.	Area Sewer in feet.	Cubic feet of capacity.
1700	6.8	36.3	61,710
2000	8.1	51.5	103,000
2650	8.8	60.8	161,120
<hr/>			<hr/>
6350			325,830

NUMBER TWO.

Acres.	Square feet of Area.	Cubic feet of water from one inch of Rainfall.
680	29,620,800	2,468,400
75	3,267,000	272,250
225	9,801,000	816,750
<hr/>		<hr/>
980	42,688,800	3,557,400

On the supposition that the main and laterals under tide will store 500,000 cubic feet, and providing also that half an inch of rainfall gets into the sewers in twelve hours, the system will be filled over three times during that time.

As a protection against storms, by forming a storing reservoir to hold any severe rain, they are useless, and if they cannot be relied on as a protection in this contingency, it is safest to discard them entirely, for in storms they fail to work successfully, and in dry weather do their work completely when least needed.

As long as the sewage is turned into the sea the free ebb and flow of the tide in the system will be most advantageous in purifying it of all foul odor and offensive stench, and the changing of water once in twelve hours, bringing in that which is fresh, will prevent, to a certain extent, decomposition in the contents.

Their influx may bring in, or may cause some suspended matters to be deposited. This constant change cannot operate more effectually to this end than by closing tide gates and allow the internal accumulations containing a larger per cent of foreign matters to stand at rest from six to twelve hours.

The flushing power of the free ebb tide with a full sewer must be more effectual than its retained contents collected in the absence of their visit, which will on the larger number of days in the year only partially fill the sewer between tides.

SIZE OF SEWER REQUIRED.

For a determination of the adequate size of the main outlet, use has been made of the formula arranged by Col. Julius W. Adams in projecting the extensive system of sewers in Brooklyn, New York. This is as follows :

$$D = \left(\frac{N^2 L}{5804 H} \right)^{\frac{1}{6}}$$

D = Diameter in feet.

N = Number of acres to be drained.

L = Length in which the sewer falls.

One foot equals H.

This formula gives sizes for sewers rising one foot in one thousand and fifty-eight feet in length, for areas as before stated, as arranged in the accompanying table.

Acres to be drained.	Diameter in feet.	Area of Sewer in feet.	Size of Sewer recommended to work under tide.	Area of Sewer proposed.
680	6.6	34.2	6.8	36.3
755	6.8	36.3	8.1	54.5
980	7.5	44.2	} 8.8	60.8
1160	7.9	49.0		

As this sewer has to work entirely under tide, delivering its contents in all conditions from that of a sewer acting freely as an outfall sewer at low tide, to one submerged by every state of the tide, from ebb to spring tide, the sizes have been increased in area to provide for the obstruction to the free flow during storms.

The subjoined table gives the sizes proposed, and the order in which they are to be arranged on the Washington street line.

Location.	Feet of Sewer.	Size of Sewer in Feet.	Diameter of equal circle in Feet.	Area in Feet.
Prospect to Joy,	1700	6.5 x 7	6.8	36.3
Joy to Waverly,	2000	7.8 x 8.3	8.1	54.5
Waverly to Tufts Dock,	2650	8.5 x 9	8.8	60.8

The form of Sewer is circular, the upper and lower semicircle being placed six inches apart joined by lines tangent to each semicircle, for the purpose of giving a ready means of removing the centers on which the upper half or arch of the sewer is laid.

This form of construction is only adapted to solid ground. Where the sewer is to be laid upon marsh mud, yielding clay, or quick sand, the bottom must be of plank, and flat, covered by an arch of dimensions equal to the area of the circular sewer. The semicircular bottom is much preferred, as it presents less space in which deposits, from either sewage or tide water can be formed and held in place.

ESTIMATE.

MILK AND BRIDGE STREET SEWER.

3850 feet 7 x 7 1-2	8" Ring	a	\$12.00	\$46,272.00
3154 " 8 x 8 1-2	12" Ring		21.00	66,234.00
28,200 Cubic yards	Excavation	a	1.30	36,660.00
8100 " "	"	a	2.00	16,200.00
9 Manholes			130.00	1,170.00
2 Gate Chambers			800.00	1,600.00
170 day Pumping			10.00	1,700.00
Cost of Pump setting and Repairs				800.00
Extra Crossing Rail Roads				500.00
Sheet piling for 1100 feet in Bridge street				4,400.00
Contingencies				5,000.00
Amount,				<u>\$180,536.00</u>

ESTIMATE.

WASHINGTON AND CAMBRIDGE STREET LINE.

1700 ft 6 1-2 x 7 ft Brick Sewer	8" Ring	11.50	19,550
2000 " 7.8 x 8.3 "	" 12" "	20.00	40,000
2650 " 8.5 x 9.0 "	" 12" "	22.00	58,300
39,500 cubic yards	Excavation includ-		
ing back filling and clearing up streets,		1.30	51,350
8 Manholes		130.00	1,040
2 Gate Chambers		800.00	1,600
170 days Pumping		10.00	1,700
Cost Pumps, Setting and Repairs			800
Right of way from Main street to Tufts Dock			8,500
Crossing Rail Roads			800
Contingencies,			5,000
Estimate,			<u>\$188,640.00</u>

To the foregoing estimate must be added the cost of about 2541 feet of small sewer built in Washington street by Somerville the present year as these would be taken up

and consequently their value lost. As an offset for the loss of the sewers in Washington street must be put the cost of the extension of the main that will be required for the Waverly street outlet, from its present termination to Prison Point Bridge, the least distance for which to the Fitchburg Rail Road Dock would be about 3660 feet. Most of this line would be over private property for which in some form the right of way would have to be obtained.

A sewer 5 1-4 x 5 feet of Brick would cost at least 10 dollars per running foot including trenching and filling over it where necessary. Therefore for the construction of this sewer an expenditure of \$36,600 would be necessary and in addition to this the cost of the right of way.

THE SQUIRE BASIN.

The Legislature directs that this basin be preserved and improved if practicable. To accomplish this it is necessary,

First—To enclose it by walling or piling with perpendicular sides.

Second—To dredge it out to not less than 18 inches below low tide, and then, to so keep it dredged, that no portion of its bed shall ever be exposed at low water.

Third—To turn all sewers from it, and put an end to its use as a receptacle of sewage or animal offal and vegetable refuse.

When thus improved and so long as it shall be maintained on these conditions it need not be an offense.

The estimated expense of improving the Squire basin, and the space between Milk street and the Boston and Lowell Rail Road is as follows :

80,000 cubic feet of mud to be dredged out and carried from the basin to some suitable place of deposit,	1.40	112,000
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Improving the sides with suitable bulk head, and filling back of same with good gravel, say		27,500
Widening bridge on Milk street to 50 feet		3,500

Amount,		<u>\$133,000.00</u>
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The above estimate is based upon the supposition that the area of these two basins will be reduced one-eighth of their present size when properly enclosed.

The average depth of excavation is about 3.5 feet, in order to remove all the mud and accomplish the purpose for which the work is done.

The present bridge under Milk street is only 18.3 feet between abutments at low water.

This narrow sluiceway interferes with the freedom of the ebb and flow of the tides. To correct this, provision has been made in the foregoing estimate for widening it to 50 feet.

The improvements pointed out only fits the Squire basin and the one between the Boston and Lowell Rail Road to remain as water area.

The truss of the Boston and Lowell Rail Road bridge extends down so far as to be covered on the base by the tide. So that at present only a very small flat boat could be towed at 1-2 or 3-4 tide from the basin to the Fitchburg Rail Road Dock.

That the Squire basin may be used for purposes of navigation, two draws must be built, one at the Boston and Lowell Railroad and one at Milk street. The one at Milk street after the bridge is widened need not be very expensive.

To build a draw at the Boston and Lowell Railroad would compel an entire remodelling of the present bridge at a very large expense.

Your attention is called to the large cost of the improvement. The expense may appear overestimated, but it has been placed at this point after consultation with a gentleman who has a thorough knowledge of the premises and who has been for many years engaged in dock building in this vicinity.

The difficulties which stand in the way of doing the work economically are unusual.

No dredging machine can be floated into it from the docks below unless draws are built for that purpose. Therefore the apparatus for doing the work must be constructed in the basin itself, and be only such as to answer for this purpose.

The next problem is to find the place to deposit the material. If carried from the basin in scows, it must be taken out at 1-2 or 3-4 tide, and then has to be passed out through several bridges and carried long distances before any suitable place can be found for it.

Its removal by cars does not appear to present any more favorable solution of this difficulty.

Considering all these conditions, the estimate is believed to be not exorbitant. The advantages to be derived from this improvement are, first the abatement of the nuisance, and next the conferring upon the local industries such benefits as would be derived from open space and a more free circulation of air than could be obtained were this space covered with dwellings or shops, and next a possibility of its use for navigation.

As to the advantage to be derived from it as navigable water, this benefit was yielded by the community when the bridges on the Boston and Lowell Railroad and Milk street were built, a relinquishment apparently by common consent, and one not easily reinstated without the highest and best reasons in its behalf.

From the chemical investigations the inference is inevitable that the nuisance is mainly derived from the industries centering around them.

The question naturally arises, for the abatement of this nuisance, shall the Corporations, that is the cities of Somerville and Cambridge, make this large expenditure in addition to the construction of proper sewers, by a mode that adds little or no valuable property to the community. If any business enterprise in this vicinity finds itself so far dependent upon the retention of these basins as water area, as to make it of vital importance to their success, there can be no objection to granting any such business the privilege of making the expenditure in its own interest, abating at the same time the nuisance it has so largely aided in creating.

But the motive actuating the cities causing them to make this large outlay stands upon very different grounds.

To abate the nuisance in these two basins by filling, will require 308,500 cubic yards of earth, and at 70 cents per cubic yard in place will cost

\$215,950

Cost to improve by dredging, &c.,

133,000

Difference,

\$82,950

In the case of filling there has been added about 712,000 square feet of valuable building land, worth at least the cost of filling.

To be retained simply as a reservoir for flushing sewers, no advantages to the tide water system in Somerville or Cambridge would equal the cost of putting it in a proper condition to be used for that purpose.

No flushing power could be derived from its use, with such ease, or that would equal the force and efficiency to be obtained from hose attached to the hydrants connected with the water works.

Finally, considering the facts connected with the defilement of these two basins, their uses and possibilities as improved; the cost of improving as compared with filling; the unremitting police oversight required in keeping them wholesome, when retained as water area; the fact that to permanently abate the present nuisance, requires a complete revolution in the system of drainage of this territory, and the establishments most promotive of the offense; and the adoption of new modes of disposing of the refuse and offal of these establishments, and that the industries around those two basins have no greater need of water space under and alongside its buildings for the transaction of their business than has the same kind of industry located above the Grand Junction Railroad; there appears no good reason why these two basins, the Squire and the one below Milk street, should be treated in any different manner than the four basins above said Grand Junction Railroad. For the four basins above said Railroad, it is conceded, as by common consent, the best that can be done is to fill them, and from all the circumstances heretofore enumerated, it seems most wise and most judicious to fill all basins above the Boston and Lowell Railroad, and to carry the main outlet sewer to the Mystic River in the manner before stated.

The views expressed as to the desirability of filling the two basins between the Grand Junction and Lowell Railroads are personal convictions derived from a study of the question as to the best manner in which the nuisance could be abated after providing for the drainage and sewage. These views may not conform to all the provisions of the law under which your Honorable Board is acting.

They are given because it was understood to be your desire that a definite opinion should be expressed upon that question as it stood related to all the basins of Miller's River above the Boston and Lowell Railroad. Therefore that opinion is submitted for your consideration.

Acknowledgments are tendered to Mr. C. D. Elliott, City Engineer of Somerville, and to J. G. Chase, Esq., City Engineer of Cambridge, for the promptness and readiness with which they have furnished tracings of maps of the cities of Somerville and Cambridge, and much other valuable information used in the foregoing report, all of which is most

Respectfully submitted,

Worcester, Nov. 26, 1872.

PHINEHAS BALL,

CIVIL ENGINEER.



